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OFFICE OF NAVAL RESEARCH LONDON (ENGLAND)
EUROPEAN SCIENTIFIC NOTES. VOLUME 6, NUMBER 13, (U)
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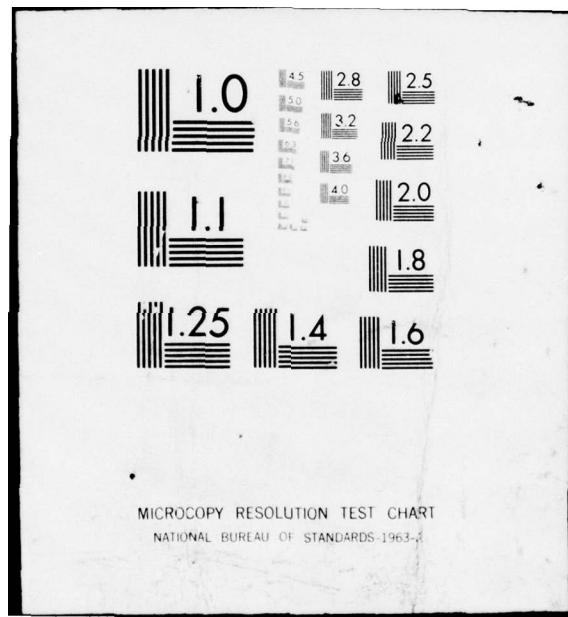
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⑥ EUROPEAN SCIENTIFIC NOTES

Vol. 6 No. 13

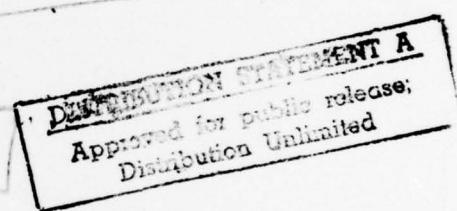
Volume 6,

Number 13,

⑩ S. R. Aspinall

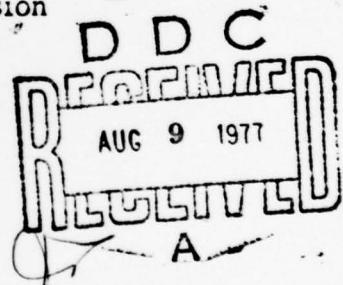
⑨ ESN-6-13

⑪ 1 July 1952



⑫ 17p.

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EUROPEAN SCIENTIFIC NOTES

1 July 1952

Vol. 6, No. 13

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EUROPEAN SCIENTIFIC NOTES

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NEW OBSERVATIONS OF HEAVY MESONS

Observations of the existence and decay of new types of heavy mesons have recently been obtained from photographic plates. As a result of these new findings the heavy mesons previously designated as kappa-mesons have now been found to consist of two different types of particles: (1) Kappa-mesons (mass 1080 ± 100) which decay into a charged μ -meson and two light neutral particles; (2) chi-mesons (mass 1470 ± 100) which undergo a 2-body decay into a charged π -meson of unique energy and a neutral particle, N^0 , of mass ~ 900 .

The Decay of Chi-Mesons

In addition to five K-mesons previously reported (Technical Report ONRL-5-52), the cosmic-ray group at the University of Bristol has now discovered five more bringing their total number up to ten. (The event previously reported as K7 in ONRL-5-52 and ESN 6, 5 (1952) is now felt to be ambiguous since it may represent the large angle scatter of a μ -meson.) In addition another K-meson has been found at Paris, one at Milan (described below), and one at Cork. The latter gave a primary track 2mm long with mass about 1350, but the secondary track was too short to be measured.

The masses of all the (primary) K-particles seemed to fall into two distinct groups when determined both by conventional methods (scattering and range) and by the photoelectric method used at the University of Lund. The crucial evidence, however, came from the fact that in about five cases the secondary particle had a

unique momentum corresponding to a value of $p\beta$ of 180 Mev/c. Three of those tracks were long enough to allow their identification as π -mesons. It was found that the corresponding primary particles were those with the higher mass of about 1500. These three cases corresponded to K7, K8, and K9 listed below.

	Primary		Secondary		Kinetic energy (Mev)
	Length (microns)	Mass	Length (microns)	Mass	
K-7	1250 \pm 1200 900		2500	290 \pm 20 183 \pm 18	120 \pm 12
K-8	2550	1460 \pm 320	7650	310 \pm 15 174 \pm 17	112 \pm 11
K-9		1380 \pm 900 450	19,500	260 \pm 15 183 \pm 18	120 \pm 12

In addition K3 and the Paris K-meson are assumed to be chi-mesons since the mean angle of scattering ($\bar{\theta} = 0.145$) of the secondary particle again yielded $p\beta = 180$ Mev/c. From the mass of the primary particle, K1 and K4 are believed to be chi-mesons.

If one interprets tentatively the neutral particle N° (of mass $\sim 900M_\pi$) arising from the chi-meson decay as a neutral tau-meson one should expect occasionally to observe its decay in flight. This event has been looked for by examining the plates carefully in the direction opposite to that taken by the π -meson. A length corresponding to 4×10^{-10} seconds has been examined but no such event has been found.

Decay of Kappa-Mesons

In two cases the secondary was positively identified as a μ -meson: in the case of K5 from grain density and scattering; in the case of K2 by the decay of the μ -meson into an electron. In these cases and others (for example, the Milan K-meson described below) the momentum of the secondary was not unique, and the primary mass corresponded to a value of about 1100. For this type of event, the original name "kappa-meson" has been retained and it is still assumed to decay into a μ -meson plus two light neutral particles.

In scanning Ilford G-5 plates 400 microns thick for μ -decays, R. Levi Setti and A. Lovati of the University of Milan have identified the decay of a kappa-meson. The plates had been flown at balloon altitudes, and were exposed vertically with the emulsions facing each other. The primary (kappa) meson, traveling downward entered from the glass of one plate and decayed in the emulsion of the other plate. The total length of the track is 2080 microns. The mass of the primary particle was determined by scattering and range measurements to be 1220 ± 240 electron masses.

The secondary track is 1400 microns long and has a grain density corresponding to minimum ionization; from measurements of the mean angle of scattering a value of $p\beta$ of 260 ± 60 Mev/c was obtained. The mass of the secondary can be assumed to be less than $400 m_e$. Since its momentum is larger than that of a secondary from a chi-meson decay, it may be assumed that it was a μ -meson from a true kappa-decay.

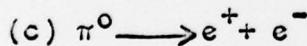
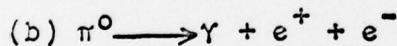
Decay of a Tau-Meson

The decay of a tau-meson has been observed by Dr. M. Ceccarelli at the University of Padova. The event took place in a G-5 emulsion 1200 microns thick which was exposed inside an aluminum shield at mountain altitudes. The track of the tau-meson has a length of 8 mm. The mass of the particle as determined from scattering and range measurements is $950 m_e$. The rest energy of the tau-meson is shared almost equally among the three decay-particles, assumed to be π -mesons. It is the best example of this type found up to date. An independent determination of the mass of the tau-meson by applying conservation-of-momentum considerations to the decay gave a value of $980 m_e$.

The photographic plate group of the University of Padova is planning further exposure at mountain altitudes of plates located in an extremely strong magnetic field. At the present time, a magnet capable of producing 70,000 gauss is being constructed and will be put into operation this summer.

THE HALF-LIFE AND DECAY OF THE NEUTRAL π -MESON

A neutral π -meson could decay in several possible ways: (a) $\pi^0 \rightarrow \gamma + \gamma$



In addition to the well known process (a), evidence for the existence of decay scheme (b) has just been obtained from photographic plates by the cosmic ray group at the University of Bristol. They recognize these decays by the existence of electron pairs very close to the nuclear

event in which the neutral π -mesons are produced. These pairs have been termed "direct", whereas pairs produced by the conversion of γ -rays from decay (a) are termed "related".

In the experimental investigation, 1425 showers were used giving 6770 charged mesons. From this figure the number of neutral mesons was estimated as 3400. The number of identified direct pairs was 15 but it was estimated that an additional 25 were not identified because their tracks were too short. The ratio for the probability of decay (b) to decay (a) is then 0.012 ± 0.004 . The experimental value is in excellent agreement with the theoretical ratio, 0.014, calculated by R.H. Dalitz of the University of Birmingham on the basis of a second-order electromagnetic process.

For the purpose of the experiment, direct pairs were defined as those at a distance less than 5μ from the star. An interesting comparison is afforded by plotting the disparity distribution for direct and related pairs. The energy division ($E_1/(E_1+E_2)$ or $E_2/(E_1+E_2)$) for related pairs is seen to be in accordance with theoretical expectation for γ -ray pair production, while the direct pairs give a pronounced peak for equal division of energy. However, the plots of total energy of the pair vs. frequency are found to be in excellent agreement in the two cases. The absence of high energy direct pairs eliminates the possibility for decay scheme (c) which should have twice the energy (i.e., the full energy of the π^0 -meson).

It was pointed out by Dalitz (Proc. Phys. Soc. A64, 667 (1951)) that the lifetime of the π^0 -meson could be determined more accurately from the direct pairs by measuring the distribution of $R/(1 - \beta^2)/\beta$ where R is the distance between the star and the origin of the pair. At the present time this method yields an upper limit of 5×10^{-14} seconds. When better statistics are obtained, this method is believed to be capable of giving a very accurate determination of the half-life of the neutral π -meson.

THE DIELECTRIC CONSTANT OF SELENIUM

Mr. H.A. Gebbie of the Services Electronics Research Laboratory, Baldock, Herts., has recently measured the index of refraction of selenium in the visible and infra-red and the dielectric constant at frequencies of

10^{10} cycles. The latter experiment was done in cooperation with Mr. D.G. Kiely. The index in the infra-red beyond two microns is about 2.45. The square of the index is then 6.00 which should be the dielectric constant at infra-red frequencies. The measured value of the dielectric constant at 10^{10} cps is $5.97 \pm .404$. The loss tangent varied among different samples from 3.2 to 5.8×10^{-3} .

The close agreement of the dielectric constant at the two widely separated frequencies strongly suggests that selenium has no significant absorption bands between the infra-red and millimeter wavelength regions, and that it should be very useful as an optical material in these wavelengths. It would not, of course, be possible to make prisms with good resolving power because of the low dispersion in this region. On the other hand, lenses of high power can be made with low curvatures because the index of refraction is so high.

HIGH-SPEED FLOWS THROUGH AIR FOIL SYSTEMS

A comprehensive program on the study of high-speed gas flows through blade systems such as are encountered in compressors and gas turbines has been started at the Institut für Gasströmungen of the Technische Hochschule, Stuttgart. Particular emphasis is to be given to investigations concerning compressibility and viscosity effects in both stationary and non-stationary flow regimes. The work is in charge of Professor A. Weise, the Institute's director, and is rapidly becoming the principal research concern of his team of eight associates and assistants.

Equipment

The central facility for the experimental phase of this program is to consist of a glass-walled test chamber in which the flow through two successive blade systems, of which one may be moving with respect to the other, can be studied by optical methods. For this purpose the customary axial flow pattern is to be converted into a radial one, the blades of the moving system being mounted on the rim of a large-diameter wheel with their span-wise direction parallel to the wheel axis. The test chamber has its glass walls parallel to the plane of the wheel and is located vertically above the axis in such a fashion that the wheel-borne blades sweep through its lower portion between the glass panels. In the upper portion the fixed cascade of air foils is mounted with their span-wise direction again

normal to the side-walls. The flow is to be established by drawing air in a radial direction down into the test chamber past the fixed and subsequently through the moving system of foils.

Optical analyses will be made by means of a four-plate interferometer of the Mach-Zehnder type which is to be installed around the test section. The light source is a high-intensity discharge lamp, and for the recording of non-stationary phenomena a rotating mirror is to be inserted into the light path after the test section. The mirror will throw the image in sequence on each of a battery of ten Kerr-cell shutters, synchronously triggered at intervals of one microsecond.

Steady flows past a single cascade or through a pair of stationary ones in various relative positions can be examined respectively by omitting the blade system on the wheel or by clamping the latter in a fixed position. A supersonic blow-down tunnel of about 8 cm x 8 cm cross section is also available in which flows around the individual profiles can first be studied.

The program is motivated by the belief that significant improvements in the efficiency of gas turbines can be obtained by reducing the losses in the aerodynamic flow. With the progressive ease of manufacturing high-temperature alloy blades to detailed profiling specifications, it becomes a matter of importance to determine aerodynamically efficient blade shapes which minimize, in particular, the losses having their origin in the non-stationary flow phenomena due to the fact that the blades of any one ring sweep alternately through the laminar and turbulent flow regimes found in the wake of the preceding blade-ring.

Instrument Development

The blue-prints for the rotating wheel installation have been completed and negotiations for its manufacture are in progress.

A set of very good interferometer plates, 20 cm square, has been preserved from the war years. These have now been assembled by Mr. K. Steegmaier in a light but rigid aluminum frame, using an arrangement originally proposed by H. Kindler, in which the plates are placed at the corners of a rectangle whose sides are in the ratio of

one to two. The whole instrument is borne on an axle through its center of gravity normal to the central plane, around which it is free to rotate. This permits the following simple and rapid procedure for adjusting the interferometer: first, the instrument is tilted so that the plates, in order to be in their proper positions, would all have to be horizontal; this is now achieved by turning each of them individually until a sensitive level indicator shows it to be horizontal. Next, the instrument is returned to its normal position, and only an appropriate parallel displacement of one of the plates is required.

Experiments are currently being carried on by Mr. M. Mechler with a single Kerr cell in order to test the feasibility of obtaining a satisfactory shutter effect with moderate voltages for which the switching problem remains manageable. So far this work is encountering considerable difficulty. No chemical firm in Germany has been found capable of distilling nitrobenzene to the necessary specification of purity, and the small amount which was produced for Weise's Institute by the Chemistry Department of the Technische Hochschule has failed to retain its purity in the cell containers which could so far be provided.

A high intensity lamp, using a 5 μ f condenser discharging through argon, has been assembled with the assistance of the Physics Department and is operating satisfactorily.

The small supersonic wind tunnel is completely installed. It is fed from a compressed air reservoir, permitting runs of about 30 seconds duration. The reservoir air is apparently not dried so that, as a precaution against water vapor condensation in the tunnel, a sequence of eight aircraft engine coolers has been inserted between the pressure reduction valve and the upstream end of the test section. These engine radiators, however, will withstand only a limited pressure, well below that of the reservoir air. A special system is therefore being developed by Mr. G. Friz for the control of the pressure reduction valve. The control signal is generated by a non-linear electronic device which is steered by the difference in current flowing through a pair of coils, one of them being wound around a mercury manometer measuring the pressure in the channel and the other one around a mercury column indicating the desired standard pressure. The non-linearity consists in having the control signal follow the error signal with a variable damping whose size increases with the latter. In this fashion the buildup of excessive oscillations is effectively avoided although the circuit reacts to small error signals with great sensitivity.

Current Research

At present, water channel and electrolytic tank analogy methods are being used to investigate stationary flows through cascades with blades of various profiles, principally from the viewpoint of their flow separation characteristics at different velocities. One idea which is being followed is that of designing blade profiles such that for an incompressible flow through the cascade the velocity remains as nearly constant as possible over the length of the profile. Such cascades should then be relatively insensitive to compressibility effects even in high-speed flows. For this purpose profiles are developed in an electrolytic tank and then transferred to a shooting water flume which is analogous to the compressible flow for a gas whose adiabatic exponent is 2. An ingenious method has been developed for plotting isobars in such flows. Since curves of constant pressure are represented by the level curves of the water surface, a fine pointed probe is mounted so as to be freely movable in a horizontal plane at a fixed but adjustable height above the bottom of the water tank. This probe is coupled to a second one executing exactly congruent motions at a small distance from a metal drawing board on which is placed a sheet of specially processed paper. A small current is fed to the probe system. The instant that the probe moving over the tank touches the water surface, a spark discharge occurs between the drawing probe and the underlying metal sheet, leaving a just visible burnt spot on the paper. As the probe is moved back and forth over the tank in a sort of hunting motion, the drawing probe generates a sequence of points which can easily be connected by a smooth curve.

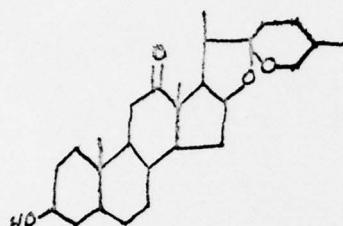
Theoretical work is carried on by Dr. K. Hess on the problem of the flow between airfoils in relative motion to each other, special attention being given to the question of the occurrence or non-occurrence of shock waves under these conditions. This is again a preparation for the analysis of non-stationary flows between the fixed and rotating blade rings of turbines and compressors.

ERRATUM: SONIC WIND TUNNEL AT MODANE

An ESN item under the above title, 15 June 1952, implied that the new sonic wind tunnel at Modane is operated by the French Air Ministry. The tunnel is operated by the Office National d'Etude et de Recherches Aeronautiques, a civilian organization, and Dr. Malavard is from O.N.E.R.A.

A NEW STARTING POINT FOR THE SYNTHESIS OF CORTISONE

In view of the shortness of the supply of bile acids from which synthetic cortisone has hitherto been made, the possibility of using vegetable steroids for this purpose has lately attracted much attention. One such is the sapogenin named hecogenin



which is present in sisal waste (R.K. Callow, J.W. Cornforth, and P.C. Spensley; Chemistry and Industry, 699, (1951)).

Dr. Callow and his group in the National Institute for Medical Research at Mill Hill, London, have recently found that hecogenin can advantageously be extracted from the juice of the leaves of the sisal plant, Agave sisalana Perrine. The procedure for the preparation of the crude sapogenin can readily be incorporated into the industrial process for the manufacture of sisal fiber. The liquid expressed from the waste product of the "dry" decortication of the leaves is allowed to ferment, when the steroid thereby released from the saponin precipitates out. This is collected by centrifugation and dried; the resultant brittle solid amounts to nearly 2 per cent of the weight of the original juice obtained from the older leaves of the plant. Juice from young leaves may yield as little as 0.3 per cent.

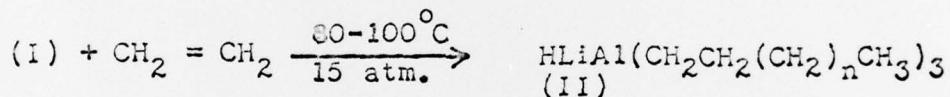
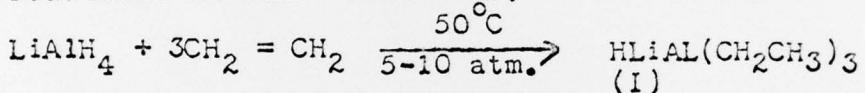
This crude hecogenin can readily be prepared on the plantations, as only simple equipment is required and no chemicals are necessary. For purification, it is suspended in normal sulfuric or hydrochloric acid and heated at about 100°C. for 3-4 hours in order to hydrolyse residual saponin. Activated charcoal is then added; after an hour or more this is collected and washed successively with cold water, dilute alkali, and water. Hecogenin is then extracted from the dried mixture with carbon tetrachloride and recrystallized from hot alcohol.

The process, a description of which has been submitted by P.C. Spensley for publication in Chemistry and Industry, has yielded over a kilogram of pure hecogenin in Dr. Callow's laboratory. Methods for its conversion into cortisone are being investigated by Dr. Cornforth. (Contributed by the State Department Science Office.)

LITHIUM ALUMINUM HYDRIDE IN OLEFIN CHEMISTRY

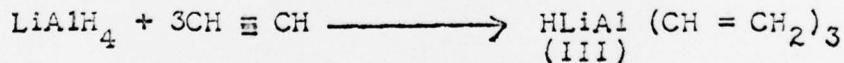
Novel synthetic methods in olefin chemistry, making use of lithium aluminum hydride, are being developed by Professor K. Ziegler (Muelheim). They yield α -mono-olefins and α, ω -diolefins of variable, controlled chain-length under relatively simple and mild conditions. The general feature of the reactions involved is that initially a simple olefin (or acetylene) is interposed in the Al - H bond (by hydrogen migration) without polymerization of the free radicals.

α -Mono-olefins are prepared by the following reactions in ether solutions:



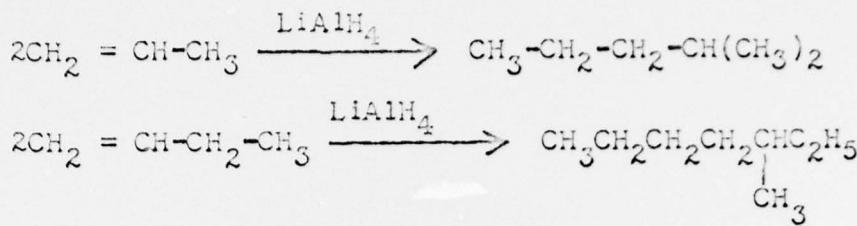
where n varies between 15 and 20.

(II), upon heating at $180 - 200^\circ\text{C}$, decomposes to yield LiAlH_4 and $\text{CH}_2 = \text{CH} - (\text{CH}_2)_n - \text{CH}_3$, an α -mono-olefin. Migration of the double bond has been observed in some cases (cf. Ang. Chem., 64, 323 (1952)). α, ω -Diolefins are prepared in an analogous manner using acetylene in the first step of the synthesis:



(III) treated with ethylene (as above) yields $\text{HLiAl}(\text{CH}_2\text{CH}_2(\text{CH}_2)_n\text{CH} = \text{CH}_2)_3$. Upon heating, the latter gives $\text{LiAlH}_4 + \text{CH}_2 = \text{CH}(\text{CH}_2)_n\text{CH} = \text{CH}_2$.

The reaction of lithium aluminum hydride with propylene and butene-1 yields useful "dimers":



The latter readily undergoes cyclization when heated with Cr_2O_3 to yield 60 per cent p-xylene, 20 per cent o-xylene, and 20 per cent ethylbenzene.

PHYSICAL CHEMISTRY RESEARCH AT MANCHESTER UNIVERSITY

Some of the work in the Physical Chemistry Department at Manchester University has been described previously (ESN 2, 59 (1948); 3, 357 (1949)). The research in this active department, headed by Professor M.G. Evans, covers a wide range of subjects in the fields of thermochemistry, kinetics of elementary reactions, bond energies, free radical chemistry, energy transfer, etc.

Drs. H.C. Longuet-Higgins, M. Szwarc, and K.S. Russell will be leaving Manchester this summer to go to London, Syracuse, New York, and Princeton, New Jersey, respectively.

The Decyclization of Cyclopropane

The unimolecular vapor phase transformation of cyclopropane into propylene is being investigated by Dr. Trotman-Dickenson, who has extended the measurements to much lower pressures than previous investigators. The experimental data continue to agree with theoretical predictions down to the lowest pressures. The transformation will be studied in the presence of hydrogen to prove that it is a true monomolecular reaction. Dr. Trotman-Dickenson is also planning to study the kinetics of a systematic series of vapor phase reactions involving simple molecules (such as $\text{Br} + \text{D}_2$) using the reaction $\text{Br} + \text{CH}_4 \longrightarrow \text{HBr} + \text{CH}_3$ as the standard of comparison.

Energetics of Coordinate Bond Formation

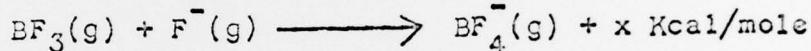
Dr. H.A. Skinner has recently surveyed the energetics of coordinate link formation, with particular reference to boron compounds, and attempted a qualitative analysis of the electron transfer process involved in the formation of these complexes. The most important factors were found to be the ionization potential of the donor, the electron affinity of the acceptor, and steric repulsion. All available evidence indicates that molecules with a high

ionization potential do not readily act as donors in complexes.

The mean bond dissociation energies are listed below. The error in these may be high.

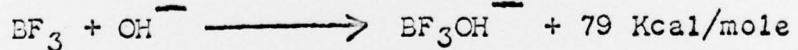
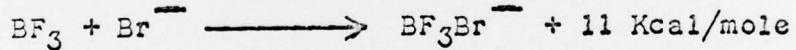
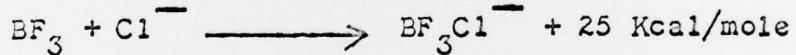
Bond	Molecule	$\overline{D}(B-X)$ Kcal/mole
B-F	BF_3	140.5
B-O	$B(OR)_3$	110 \pm 5
B-Cl	BCl_3	93.6
B-Br	BBr_3	74.7
B-C	$B(CH_3)_3$	73.9

The electron affinity of BF_3 was estimated via the reaction



Using known data for the necessary quantities (including 83 Kcal/mole for the electron affinity of fluorine) the heat of the above reaction was estimated as 75 ± 6 Kcal/mole. This leads to a lower limit of 18 Kcal/mole for the electron affinity of BF_3 .

The following values were obtained for the heat of addition of several gaseous anions:



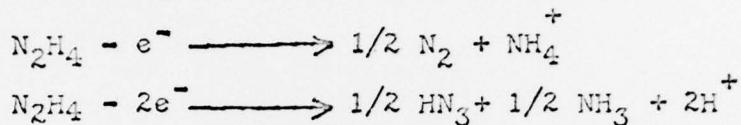
These results are in satisfactory agreement with the known instability of BF_3Cl^- and of BF_3Br^- .

The energetics of the boron trifluoride-dimethyl ether complex was examined in some detail. Its energy of dissociation is -13.9 Kcal/mole. By combining this datum with the known ionization potential of the donor (242 Kcal/mole) and the

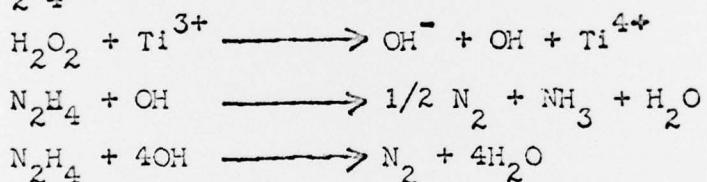
B-O bond energy, a value 0.58 is obtained for k in the electrostatic term $k \epsilon^2/r^3$. k is essentially a measure of the asymmetry of sharing of the electrons forming the coordinate link. This value obtained by Skinner is in excellent agreement with that obtained by Sutton from dipole moment data.

The Oxidation of Hydrazine

Hydrazine can be oxidized in solution in two ways according to the reaction schemes:



The second reaction may involve the intermediate N_2H_2^+ . Dr. W.C.E. Higginson substantiated previous suggestions that it is the number of electrons subtracted by the oxidizing agent which determines the course of the reaction. Hydroxyl radicals were shown to oxidize hydrazine according to the first reaction, while thallic ions oxidize according to the second reaction. The hydroxyl radical oxidation was performed by adding H_2O_2 to a mixture of TiCl_3 and $\text{N}_2\text{H}_4 \cdot 2\text{HCl}$. The following reactions take place:



The latter reaction is favored at high OH concentrations. The detailed mechanism of the oxidation reactions is being further studied using isotopic $\text{N}_2^{15}\text{H}_4$ and analyzing the products mass spectroscopically.

TECHNICAL REPORTS OF ONRL

The following reports have been forwarded to ONR, Washington, since the last issue of ESN. Copies may be obtained from the Technical Information Office, Code 250, Office of Naval Research, Washington 25, D.C.

ONRL-38-52 "Centre de Recherches Scientifiques, Industrielles et Maritimes Marseille, France" by H.A. Imus

ONRL-41-52 "The Institute of Optics in Madrid" by W.L. Hyde

CNRL-43-52 "Conference on the British Contribution to Television" by W.L. Hyde and R.R. Weber

ONRL-44-52 "The Optical Instruments at the 36th Annual Physical Society Exhibition" by W.L. Hyde

ONRL-54-52 "Conference on Adhesion" by R.W. Mooney

ONRL-57-52 "Approach to Postgraduate Medical Education in Great Britain" by J.P. Wood

ONRL-58-52 "Further Studies on Marine Biology" by W.J. Perry

ONRL-66-52 "Atmospheric Radioactivity Following Nuclear Explosions" by W.L. Hyde

NEW JOURNAL

A new international journal on the Mechanics and Physics of Solids is being published by the Pergamon Press Ltd., London. The British Editor is Dr. R. Hill, Department of Theoretical Mechanics, University of Bristol.

FORTHCOMING EVENTS

A summer school in programme design for automatic digital computing machines will be held in the University Mathematical Laboratory at Cambridge during the period 16 - 26 September. It will be along the same lines as those held previously. A detailed syllabus and application form may be obtained from G.F. Hickson, Esq., M.A., Secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

A one-day conference will be held at Manchester University on 29 October 1952 on Optical and Electron Microscopical Properties of Textile Fibres. The conference is sponsored by The Manchester Section of the Institute of Physics. Further information may be obtained from the Institute of Physics, 1 Lowther Gardens, London, S.W. 7

The Fourth International Astrophysical Conference is to be held at the Astrophysical Institute of the University of Liège from 19-21 September 1952, and will be on

"The Physics of Comets". Sessions will be devoted to discovery, photometry, spectroscopy, spectrophotometry, experimental and theoretical related spectroscopic topics, structure of the head and tail, processes of formation and evolution, and comet atmospheres. Thirty papers have already been announced and others will be welcome. Correspondence should be addressed to Professor P. Swings, Institut d'Astrophysique, Cointe-Sclessin, Belgique.

Prepared by the Scientific Staff
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